APPENDIX 5 : System Validation Dipole (D5GHzV2,S/N: 1020)

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IMPORTANT NOTICE

DIPOLE TRANSPORTATION CASE

Important Note:

Please use only this suitcase for any future dipole transportation!

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Schmid & Partner Engineering AG

June 2003

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client UL A-Pex (MTT)

CALIBRATION CERTIFICATE

Object(s)	D5GHzV2 - SN:1020
Calibration procedure(s)	QA CAL-05 v2 Calibration procedure for dipole validation kits
Calibration date:	February 23, 2004
Condition of the calibrated item	In Tolerance (according to the specific calibration document)

This calibration statement documents traceability of M&TE used in the calibration procedures and conformity of the procedures with the ISO/IEC 17025 international standard.

All calibrations have been conducted in the closed laboratory facility: environment temperature 22 +/- 2 degrees Celsius and humidity < 75%.

Calibration Equipment used (M&TE critical for calibration)

Model Type	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E4419B	GB41293874	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor E4412A	MY41495277	2-Apr-03 (METAS, No 252-0250)	Apr-04
Power sensor HP 8481A	MY41092317	18-Oct-02 (Agilent, No. 20021018)	Oct-04
RF generator R&S SMT06	100058	23-May-01 (SPEAG, in house check May-03)	In house check: May-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-03)	In house check: Oct 05

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Laboratory Director	
Approved by:	Fin Bomholt	R&D Director	

Date issued: February 26, 2004

This calibration certificate is issued as an intermediate solution until the accreditation process (based on ISO/IEC 17025 International Standard) for Calibration Laboratory of Schmid & Partner Engineering AG is completed.

Schmid & Partner Engineering AG

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DASY

Dipole Validation Kit

Type: D5GHzV2

Serial: 1020

Manufactured: February 5, 2004
Calibrated: February 23, 2004

1. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with **head simulating solution** of the following electrical parameters:

Frequency:	**5200 MHz**	
Relative Dielectricity	**36.3**	± 5%
Conductivity	**4.57 mho/m**	± 5%
Frequency:	**5800 MHz**	
Relative Dielectricity	**35.4**	± 5%
Conductivity	**5.20 mho/m**	± 5%

The DASY4 System with a dosimetric E-field probe EX3DV3 - SN:3503 was used for the measurements. The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. Lossless spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 10mm was aligned with the dipole. Special 8x8x8 fine cube was chosen for cube integration (dx=dy=4.3mm, dz=3mm). Distance between probe sensors and phantom surface was set to 2.5 mm. The dipole input power (forward power) was 250 mW ± 3 %. The results are normalized to 1W input power.

2. SAR Measurement with DASY System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figures supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured at **5200 MHz (Head Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue: **87.6 mW/g** ± 20.3 % (k=2)[1]

averaged over 10 cm^3 (10 g) of tissue: **24.5 mW/g** ± 19.8 % (k=2)[1]

The resulting averaged SAR-values measured **at 5800 MHz (Head Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue: **86.8 mW/g** ± 20.3 % (k=2)[2]

averaged over 10 cm^3 (10 g) of tissue: **24.2 mW/g** ± 19.8 % (k=2)[2]

[1] Target dipole values determined by FDTD (feedpoint impedance set to 50 Ohm). The values are SAR_1g=76.5 mW/g, SAR_10g=21.6 mW/g and SAR_peak=310.3 mW/g.

[2] Target dipole values determined by FDTD (feedpoint impedance set to 50 Ohm). The values are SAR_1g=78.0 mW/g, SAR_10g=21.9 mW/g and SAR_peak=340.9 mW/g.

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3. Dipole Transformation Parameters

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint (please refer to the graphics attached to this document). The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay:	**1. 200 ns**	(one direction)
Transmission factor:	**0.974**	(voltage transmission, one direction)

4. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with **body simulating solution** of the following electrical parameters:

Frequency:	**5200 MHz**	
Relative Dielectricity	**49.7**	± 5%
Conductivity	**5.18 mho/m**	± 5%
Frequency:	**5800 MHz**	
Relative Dielectricity	**48.5**	± 5%
Conductivity	**6.01 mho/m**	± 5%

The DASY3 System with a dosimetric E-field probe EX3DV3 - SN:3503 was used for the measurements. The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm from dipole center to the solution surface. Lossless spacer was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 10mm was aligned with the dipole. The 8x8x8 fine cube was chosen for cube integration (dx=dy=4.3mm, dz=3mm). Distance between probe sensors and phantom surface was set to 2.5 mm. The dipole input power (forward power) was 250 mW ± 3 %. The results are normalized to 1W input power.

5. SAR Measurement with DASY System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. The results (see figures supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured at **5200 MHz (Body Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue: **82.0 mW/g** ± 20.3 % (k=2)[3]

averaged over 10 cm^3 (10 g) of tissue: **23.0 mW/g** ± 19.8 % (k=2)[3]

The resulting averaged SAR-values measured **at 5800 MHz (Body Tissue)** with the dosimetric probe EX3DV3 SN:3503 and applying the advanced extrapolation are:

averaged over 1 cm^3 (1 g) of tissue: **78.4 mW/g** ± 20.3 % (k=2)[4]

averaged over 10 cm^3 (10 g) of tissue: **21.5 mW/g** ± 19.8 % (k=2)[4]

6. Handling

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

7. Design

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

Small end caps have been added to the dipole arms in order to increase frequency bandwidth at the position as explained in Sections 1and 4.

8. Power Test

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

[3] Target dipole values determined by FDTD (feedpoint impedance set to 50 Ohm). The values are SAR_1g=71.8 mW/g, SAR_10g=20.1 mW/g and SAR_peak=284.7 mW/g.

[4] Target dipole values determined by FDTD (feedpoint impedance set to 50 Ohm). The values are SAR_1g=74.1 mW/g, SAR_10g=20.5 mW/g and SAR_peak=324.7 mW/g.

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Date/Time: 02/20/04 17:12:14

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Serial: D5GHzV2 - SN:1020

Communication System: CW-5GHz;Duty Cycle: 1:1;Medium: HSL5800

Medium parameters used: f = 5200 MHz; $\sigma = 4.57$ mho/m; $\varepsilon_r = 36.3$; $\rho = 1000$ kg/m^3

Medium parameters used: f = 5800 MHz; $\sigma = 5.2$ mho/m; $\varepsilon_r = 35.4$; $\rho = 1000$ kg/m^3

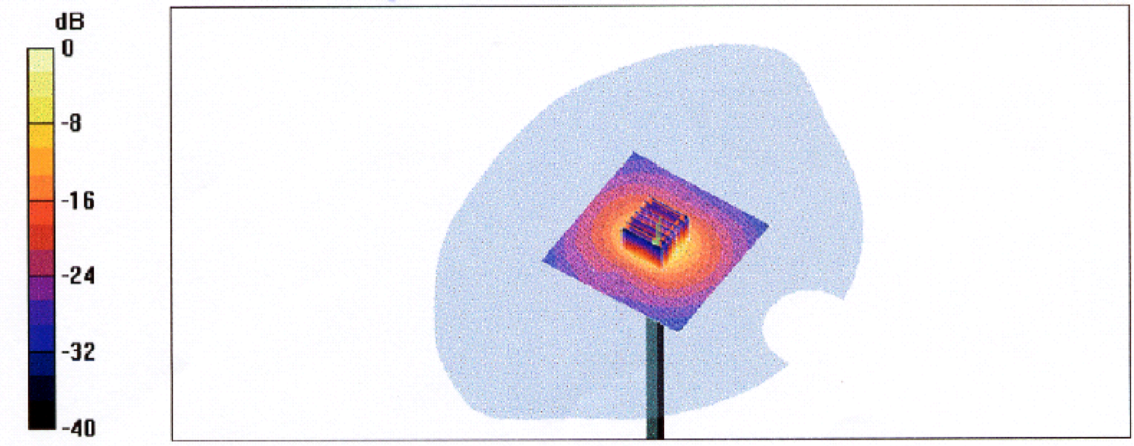
DASY4 Configuration:

- Probe: EX3DV3 - SN3503; ConvF(5.7, 5.7, 5.7)
  ConvF(5, 5, 5); Calibrated: 6/27/2003
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 600; Calibrated: 9/30/2003
- Phantom: SAM with CRP - TP:1312; Phantom section: Flat Section
- Measurement SW: DASY4, V4.2 Build 30; Postprocessing SW: SEMCAD, V1.8 Build 98

d=10mm, Pin=250mW, f=5200 MHz/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Reference Value = 97.3 V/m
Power Drift = 0.0 dB
Maximum value of SAR = 40.4 mW/g

d=10mm, Pin=250mW, f=5800 MHz 2/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:
Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm
Peak SAR (extrapolated) = 89.6 W/kg
SAR(1 g) = 21.5 mW/g; SAR(10 g) = 6.05 mW/g

d=10mm, Pin=250mW, f=5200 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:
Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm
Peak SAR (extrapolated) = 85 W/kg
SAR(1 g) = 21.9 mW/g; SAR(10 g) = 6.12 mW/g



0 dB = 36.3mW/g

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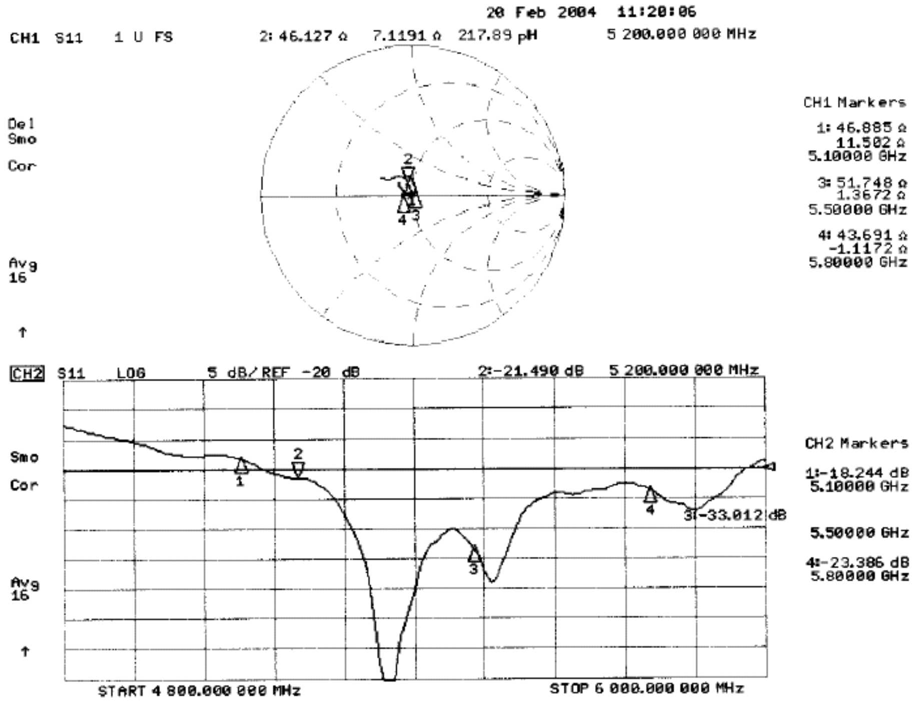
Head


20 Feb 2004 11:20:06
CH1 S11 1 U FS 2: 46.127 Ω 7.1191 Ω 217.89 pH 5 200.000 000 MHz
Del
Smo
Cor
Avg
16
CH1 Markers
1: 46.885 Ω
11.502 Ω
5.10000 GHz
3: 51.748 Ω
1.3672 Ω
5.50000 GHz
4: 43.691 Ω
-1.1172 Ω
5.80000 GHz
CH2 S11 LOG 5 dB/ REF -20 dB 2:-21.490 dB 5 200.000 000 MHz
Smo
Cor
Avg
16
3:-33.012 dB
CH2 Markers
1:-18.244 dB
5.10000 GHz
5.50000 GHz
4:-23.386 dB
5.80000 GHz
START 4 800.000 000 MHz
STOP 6 000.000 000 MHz

Page 1 of 1

Date/Time: 02/23/04 19:20:57

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 5GHz; Serial: D5GHzV2 - SN:1020

Communication System: CW-5GHz;Duty Cycle: 1:1;Medium: MSL5800
Medium parameters used: f = 5200 MHz; σ = 5.18 mho/m; ε_r = 49.7; ρ = 1000 kg/m^3
Medium parameters used: f = 5800 MHz; σ = 6.01 mho/m; ε_r = 48.5; ρ = 1000 kg/m^3

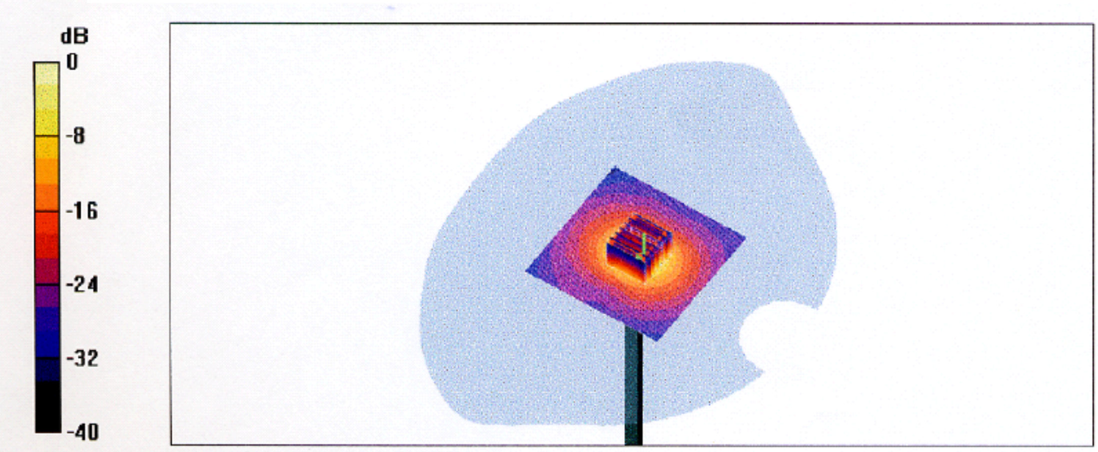
DASY4 Configuration:

- Probe: EX3DV3 - SN3503; ConvF(5, 5, 5)
  ConvF(4.6, 4.6, 4.6); Calibrated: 6/27/2003
- Sensor-Surface: 2.5mm (Mechanical Surface Detection)
- Electronics: DAE4 600; Calibrated: 9/30/2003
- Phantom: SAM with CRP - TP:1312; Phantom section: Flat Section
- Measurement SW: DASY4, V4.2 Build 34; Postprocessing SW: SEMCAD, V1.8 Build 105

d=10mm, Pin=250mW, f=5200 MHz/Area Scan (91x91x1): Measurement grid: dx=10mm, dy=10mm
Reference Value = 80.3 V/m; Power Drift = 0.0 dB
Maximum value of SAR (interpolated) = 37.5 mW/g

d=10mm, Pin=250mW, f=5800 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:
Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm
Peak SAR (extrapolated) = 80.6 W/kg
SAR(1 g) = 19.6 mW/g; SAR(10 g) = 5.38 mW/g

d=10mm, Pin=250mW, f=5200 MHz/Zoom Scan (8x8x8), dist=2.5mm (7x7x8)/Cube 0:
Measurement grid: dx=4.3mm, dy=4.3mm, dz=3mm
Peak SAR (extrapolated) = 71.6 W/kg
SAR(1 g) = 20.5 mW/g; SAR(10 g) = 5.74 mW/g



0 dB = 33.6mW/g

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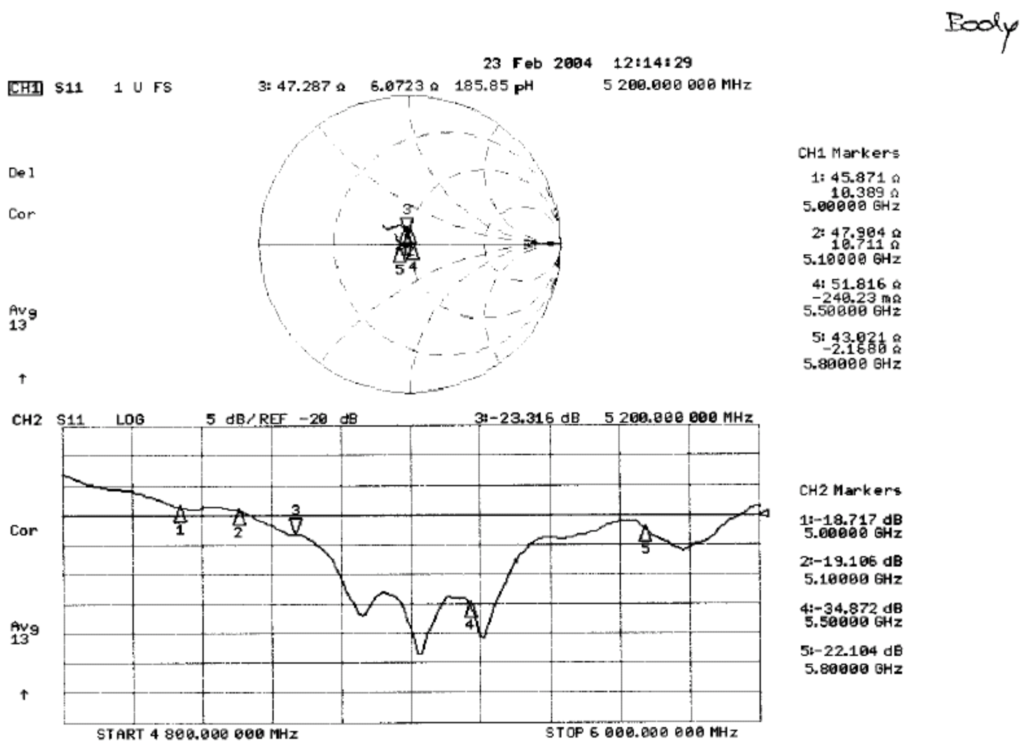
Body
23 Feb 2004 12:14:29
CH1 S11 1 U FS 3: 47.287 Ω 6.0723 Ω 185.85 pH 5 200.000 000 MHz
Del
Cor
Avg
13
CH1 Markers
1: 45.871 Ω
10.389 Ω
5.00000 GHz
2: 47.904 Ω
10.711 Ω
5.10000 GHz
4: 51.816 Ω
-240.23 mΩ
5.50000 GHz
5: 43.021 Ω
-2.1680 Ω
5.80000 GHz
CH2 S11 LOG 5 dB/ REF -20 dB 3:-23.316 dB 5 200.000 000 MHz
Cor
Avg
13
CH2 Markers
1:-18.717 dB
5.00000 GHz
2:-19.106 dB
5.10000 GHz
4:-34.872 dB
5.50000 GHz
5:-22.104 dB
5.80000 GHz
START 4 800.000 000 MHz
STOP 6 000.000 000 MHz

APPENDIX 6 : Dosimetric E-field Probe Calibration (EX3DV4, S/N:3540)

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S Swiss Calibration Service

Accredited by the Swiss Federal Office of Metrology and Accreditation
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **MTT** | **Certificate No: EX3-3540_Jan05**

CALIBRATION CERTIFICATE

Object	**EX3DV4 - SN:3540**
Calibration procedure(s)	**QA CAL-01.v5** **Calibration procedure for dosimetric E-field probes**
Calibration date:	**January 14, 2005**
Condition of the calibrated item	**In Tolerance**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	5-May-04 (METAS, No. 251-00388)	May-05
Power sensor E4412A	MY41495277	5-May-04 (METAS, No. 251-00388)	May-05
Reference 3 dB Attenuator	SN: S5054 (3c)	10-Aug-04 (METAS, No. 251-00403)	Aug-05
Reference 20 dB Attenuator	SN: S5086 (20b)	3-May-04 (METAS, No. 251-00389)	May-05
Reference 30 dB Attenuator	SN: S5129 (30b)	10-Aug-04 (METAS, No. 251-00404)	Aug-05
Reference Probe ES3DV2	SN: 3013	7-Jan-05 (SPEAG, No. ES3-3013_Jan05)	Jan-06
DAE4	SN: 617	29-Sep-04 (SPEAG, No. DAE4-617_Sep04)	Sep-05

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092180	18-Sep-02 (SPEAG, in house check Oct-03)	In house check: Oct 05
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Dec-03)	In house check: Dec-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov 05

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Technical Manager	
Approved by:	Fin Bomholt	R&D Manager	

Issued: January 14, 2005

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) CENELEC EN 50361, "Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz - 3 GHz), July 2001

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY 4.3 B17 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

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Probe EX3DV4

SN:3540

Manufactured: August 23, 2004
Calibrated: January 14, 2005

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

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DASY - Parameters of Probe: EX3DV4 SN:3540

Sensitivity in Free Space[A]

NormX	**0.47** ± 10.1%	$\mu V/(V/m)^2$
NormY	**0.54** ± 10.1%	$\mu V/(V/m)^2$
NormZ	**0.49** ± 10.1%	$\mu V/(V/m)^2$

Diode Compression[B]

DCP X	**92** mV
DCP Y	**92** mV
DCP Z	**92** mV

Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 9.

Boundary Effect

TSL **900 MHz** **Typical SAR gradient: 5 % per mm**

Sensor Center to Phantom Surface Distance		**2.0 mm**	**3.0 mm**
SAR_{be} [%]	Without Correction Algorithm	3.5	1.3
SAR_{be} [%]	With Correction Algorithm	0.2	0.5

TSL **1810 MHz** **Typical SAR gradient: 10 % per mm**

Sensor Center to Phantom Surface Distance		**2.0 mm**	**3.0 mm**
SAR_{be} [%]	Without Correction Algorithm	4.4	2.5
SAR_{be} [%]	With Correction Algorithm	1.0	0.6

Sensor Offset

Probe Tip to Sensor Center **1.0** mm

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Page 9).

[B] Numerical linearization parameter: uncertainty not required.

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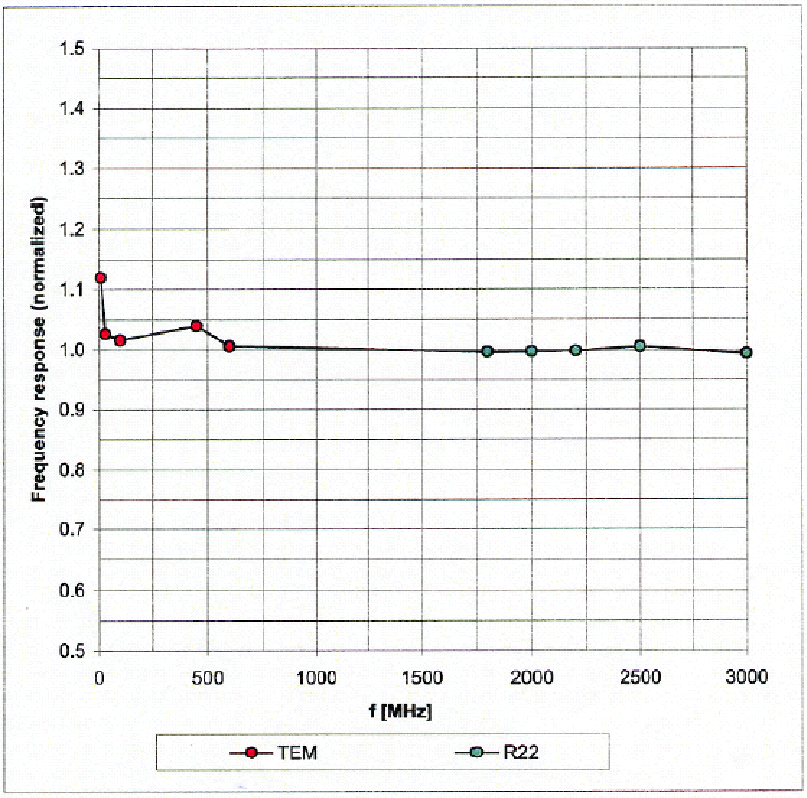
EX3DV4 SN:3540 January 14, 2005

Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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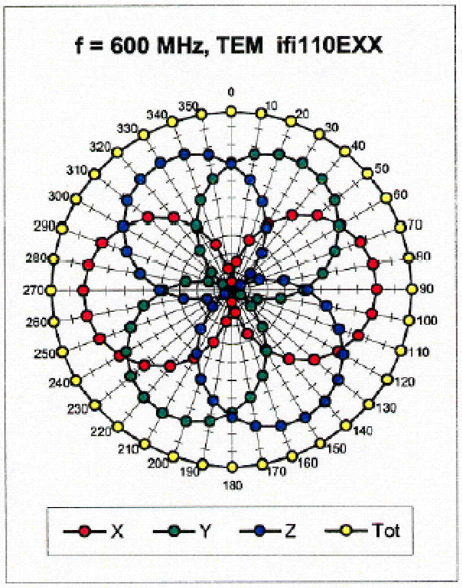
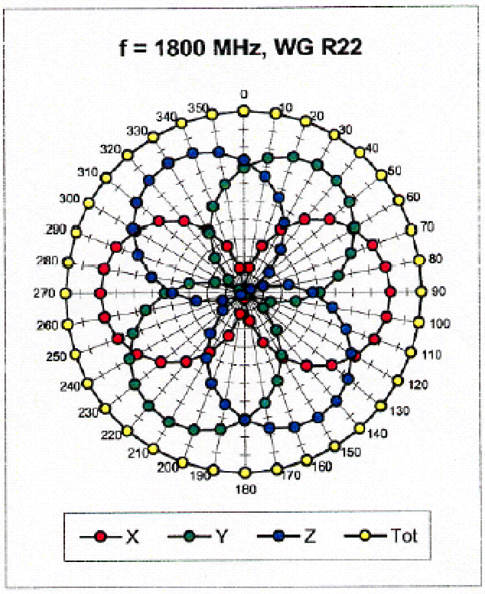
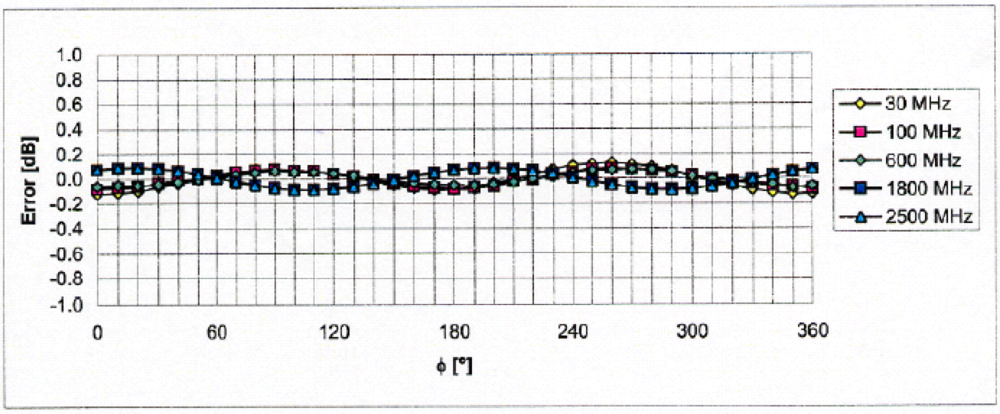
EX3DV4 SN:3540 January 14, 2005

Receiving Pattern (ϕ), ϑ = 0°







Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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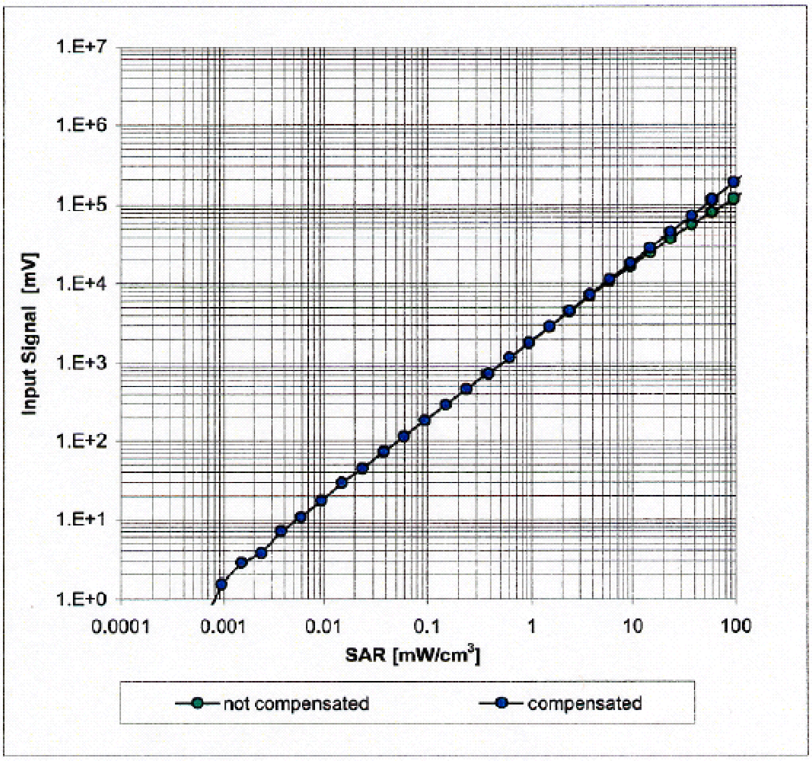
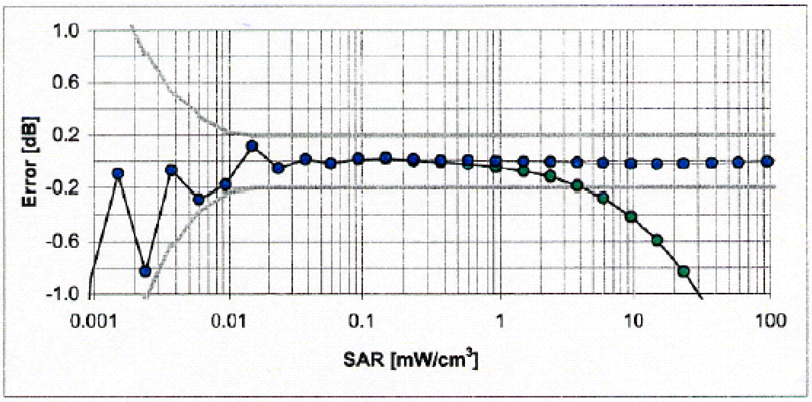
EX3DV4 SN:3540 January 14, 2005

Dynamic Range f(SAR_{head})

(Waveguide R22, f = 1800 MHz)





Uncertainty of Linearity Assessment: ± 0.6% (k=2)

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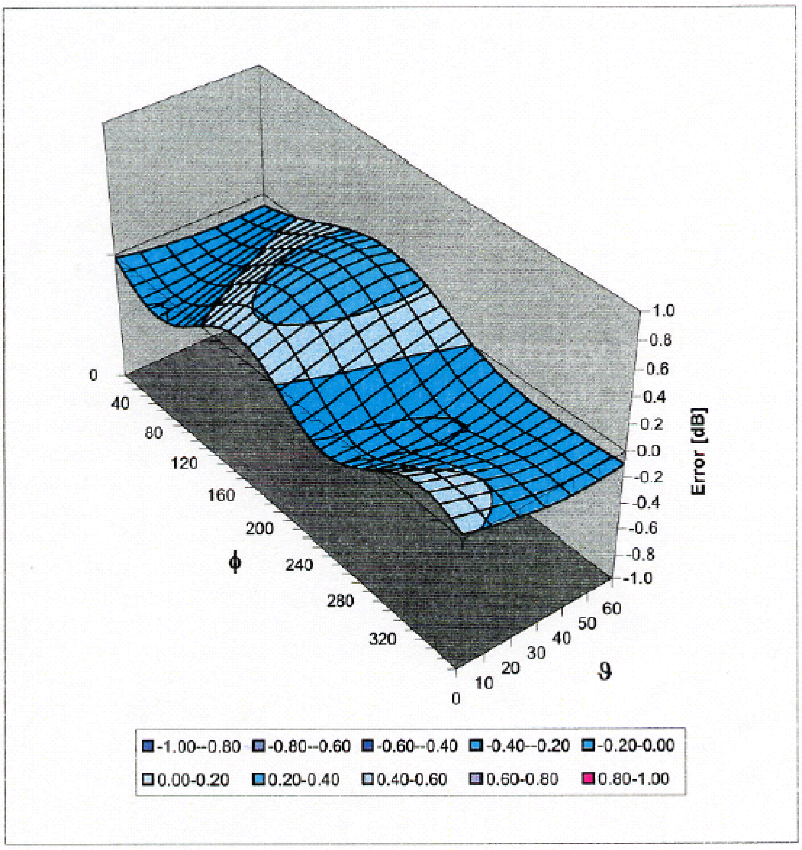
Deviation from Isotropy in HSL

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

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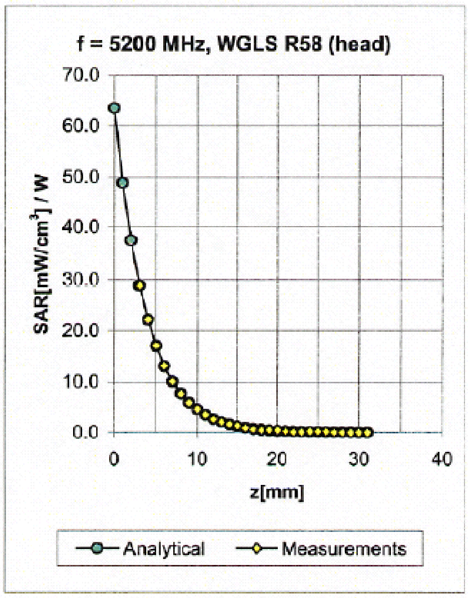
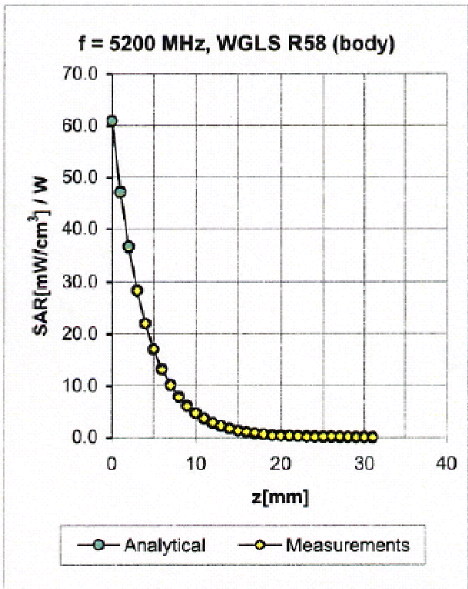
Appendix[D]





f [MHz][D]	Validity [MHz]	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF	Uncertainty
5200	± 50	Head	36.0 ± 5%	4.76 ± 5%	0.45	1.80	4.79	± 13.6% (k=2)
5800	± 50	Head	35.3 ± 5%	5.27 ± 5%	0.45	1.80	4.34	± 13.6% (k=2)
5200	± 50	Body	49.0 ± 5%	5.30 ± 5%	0.45	1.90	4.40	± 13.6% (k=2)
5800	± 50	Body	48.2 ± 5%	6.00 ± 5%	0.43	1.90	4.06	± 13.6% (k=2)

[D] Accreditation for ConvF assessment above 3000 MHz is currently applied for. Accreditation is expected at the beginning of 2005.

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